Civil & Commercial Applications Project (CCAP): Evaluation of QuickBird Imagery Suitability for Feature Extraction

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Study Objective

- Determine through confidence ratings relating to extraction and objective questions relating to attribution, the utility of QuickBird panchromatic, multispectral, and pan-sharpened imagery for feature extraction used for all applicable NIMA digital geospatial products.

Approach

- 6 Geospatial Analysts/Cartographers
- 265 Image chips; 29 unique geographic locations
  - 112 Pan (Basic 1B)
  - 112 MSI (Basic 1B)
  - 41 Pan-Sharpened MSI (Standard 2A)
- Data were analyzed to determine the suitability and information content of QuickBird imagery products in support of standard extraction and attribution tasks
  - Categories derived from the Feature and Attribute Coding Coding Catalog (FACC)

Approach, cont.

- Conducted at NIMA/AEAI's softcopy evaluation facility from workstations with calibrated precision color monitors

- Image sets were randomly displayed with the caveat that pan-sharpened imagery was displayed last

- Each participant reviewed a sequence of scenes
  - Provided a confidence rating (0 - 100) on their ability to extract a given feature
  - Once a response was given, the software displayed the image chip with a vector annotation around the feature in question
  - A series of multiple choice and yes/no questions were then asked about the attributes associated with that feature

Feature Selection

- Features in this evaluation fall into broad coverage categories as listed in the FACC

- Some overlap of features exists between coverage categories

- All confidence ratings and yes/no attribute responses for features were grouped by coverage category and averaged for each QuickBird product type
  - This allowed for comparisons of products by general mapping applications

- Multiple choice attribute responses were grouped by attribute category, compared with predetermined ground truth, and averaged for each QuickBird product type

Coverage Categories

- Nine FACC coverage categories used
  - Ground Obstacle
  - Hydrography
  - Industry
  - Physiography
  - Population
  - Surface Drainage (SDR)
  - Transportation
  - Utility
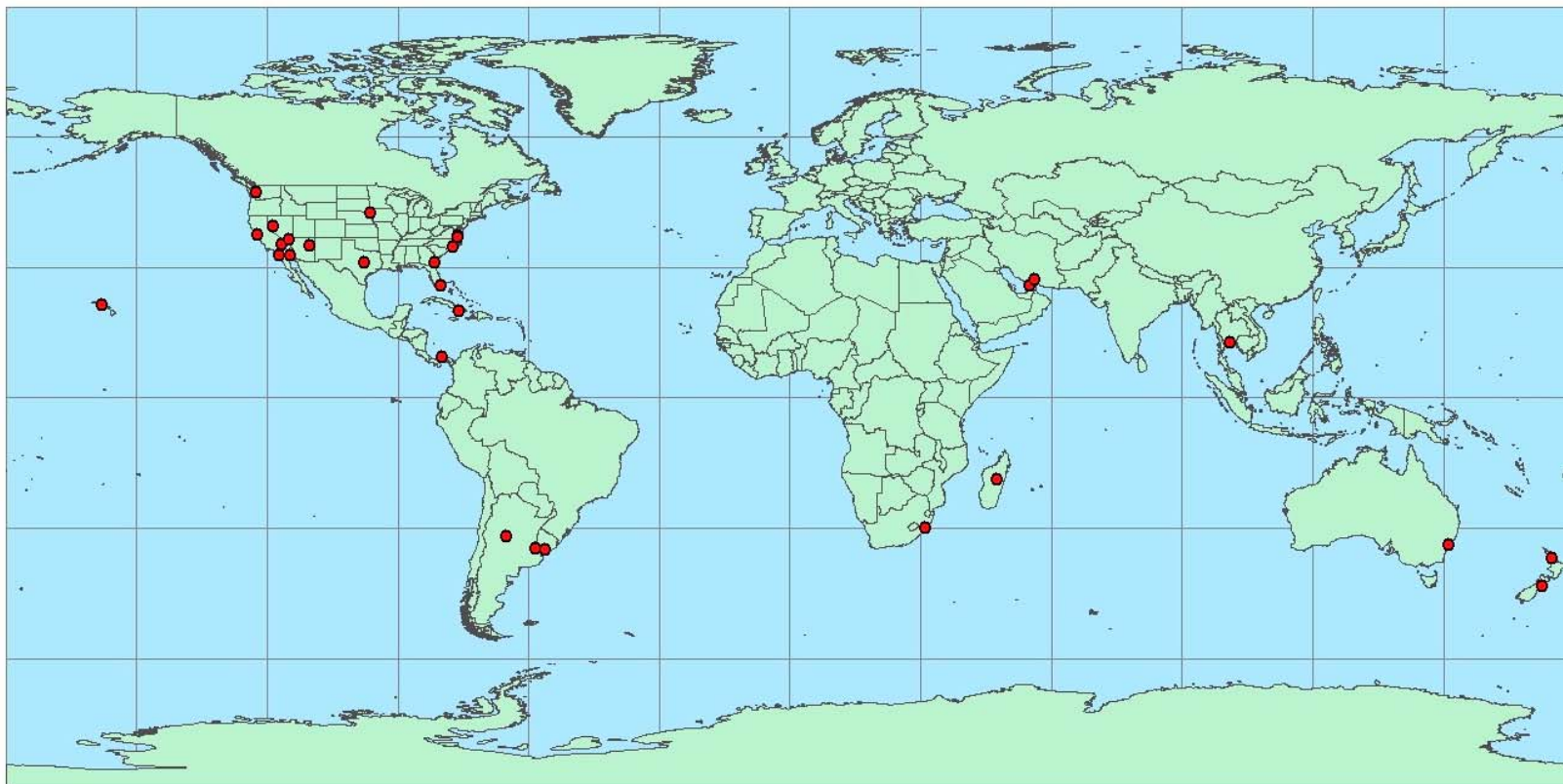 - Vegetation

Attribute Categories

- Fourteen attribute categories used

    - Accuracy
    - Existence
    - Hydrology
    - Infrastructure
    - Location
    - Material Composition
    - Other

    - Product
    - Structure/Shape
    - Surface Condition
    - Surface Type
    - Usage
    - Vegetation Characteristics
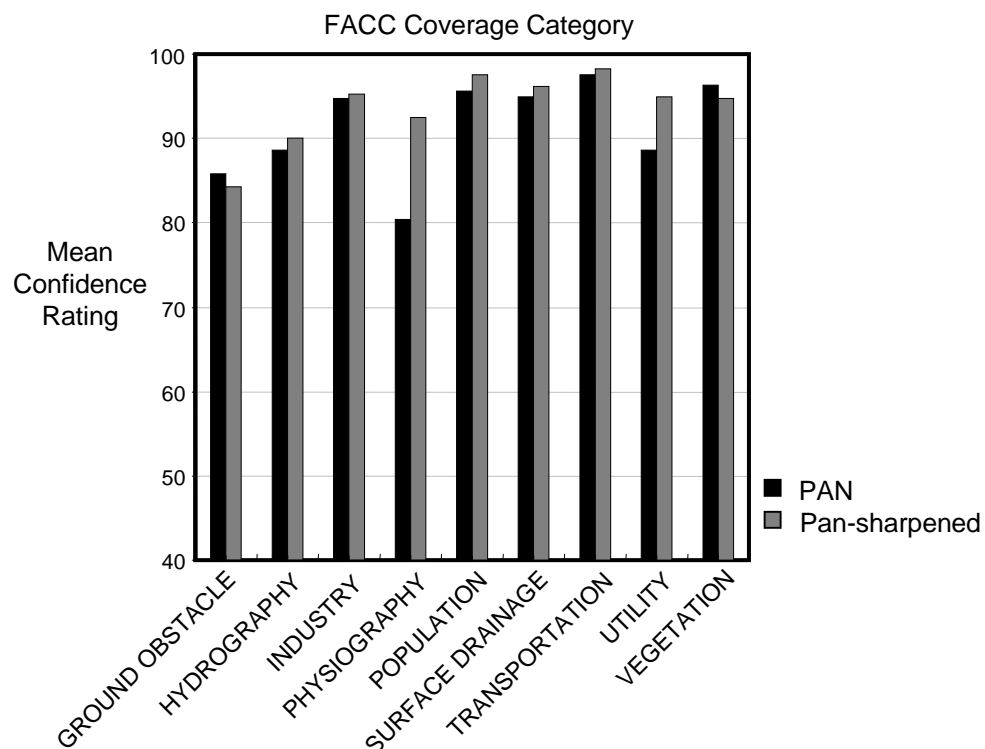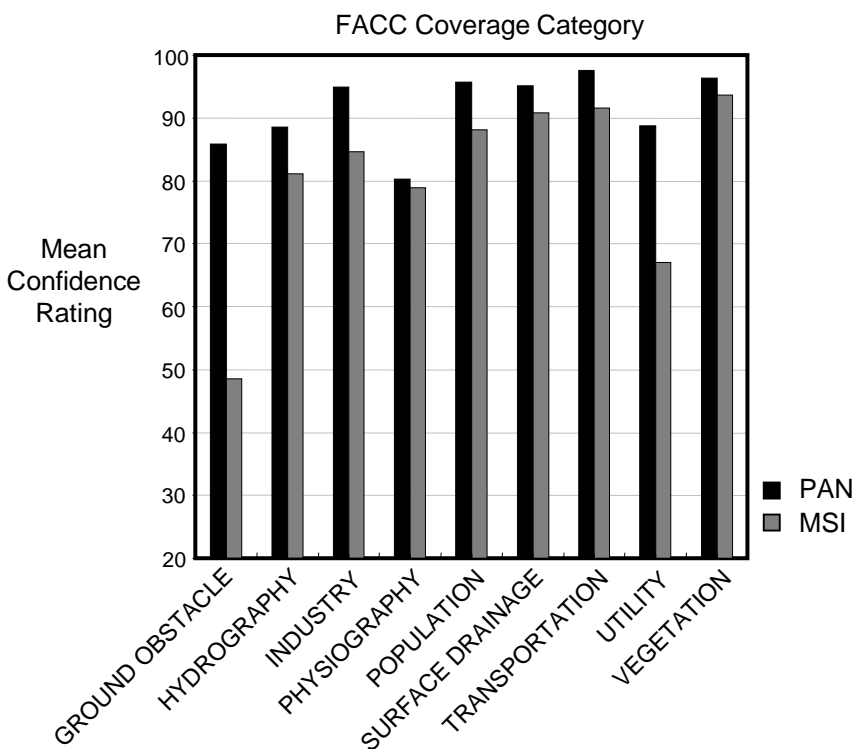   - Weather Type

Scene Locations

Analysis

- Six Geospatial Analysts/Cartographers reviewed 743 features
  - 743 Confidence ratings per analyst
  - 681 yes/no attribute responses per analyst
  - 1328 multiple choice attribute responses per analyst
- Set of confidence ratings for one Geospatial Analyst/Cartographer was considered an outlier and discarded from analysis
- All attribute responses were considered acceptable and used for analysis

Mean Confidence

FACC Coverage Category

Mean Confidence Rating — PAN, MSI — categories: GROUND OBSTACLE, HYDROGRAPHY, INDUSTRY, PHYSIOGRAPHY, POPULATION, SURFACE DRAINAGE, TRANSPORTATION, UTILITY, VEGETATION

FACC Coverage Category

Mean Confidence Rating — PAN, Pan-sharpened — categories: GROUND OBSTACLE, HYDROGRAPHY, INDUSTRY, PHYSIOGRAPHY, POPULATION, SURFACE DRAINAGE, TRANSPORTATION, UTILITY, VEGETATION

Pan/MSI Results

- In most cases, Pan and MSI performed similarly in all categories with Pan ratings 2 to 10 points higher
    - Notable differences in confidence between image types were in the Ground Obstacle and Utility categories
        - 85.9 for Pan (Ground Obstacle)
        - 48.4 for MSI (Ground Obstacle)
        - 88.7 for Pan (Utility)
        - 66.9 for MSI (Utility)
    - The Pan image product had the highest mean confidence rating in the Transportation category (97.6) and the lowest mean confidence in the Physiography category (80.4)
    - The MSI image product had the highest mean confidence rating in the Vegetation category (93.7) and the lowest mean confidence in the Ground Obstacle category (48.4)

Pan-sharpened Results

- In most cases, Pan-sharpened image types performed similarly to Pan image types
  - Notable differences in confidence between image types were in the Physiography and Utility categories
    - 92.4 for Pan-sharpened (Physiography)
    - 80.4 for Pan (Physiography)
    - 94.9 for Pan-sharpened (Utility)
    - 88.7 for Pan (Utility)
  - The highest mean confidence rating for the Pan-sharpened product was in the Transportation category (98.3) and the lowest rating was in the Ground Obstacle category (84.3)
- Fewer Pan-sharpened image chips in all coverage categories
  - At best, only half the number of Pan-sharpened chips were represented in the coverage categories
  - Four coverage categories represented with only 3-5 chips (Ground Obstacle, Hydrography, Physiography, Vegetation)

Positive Attribute Responses
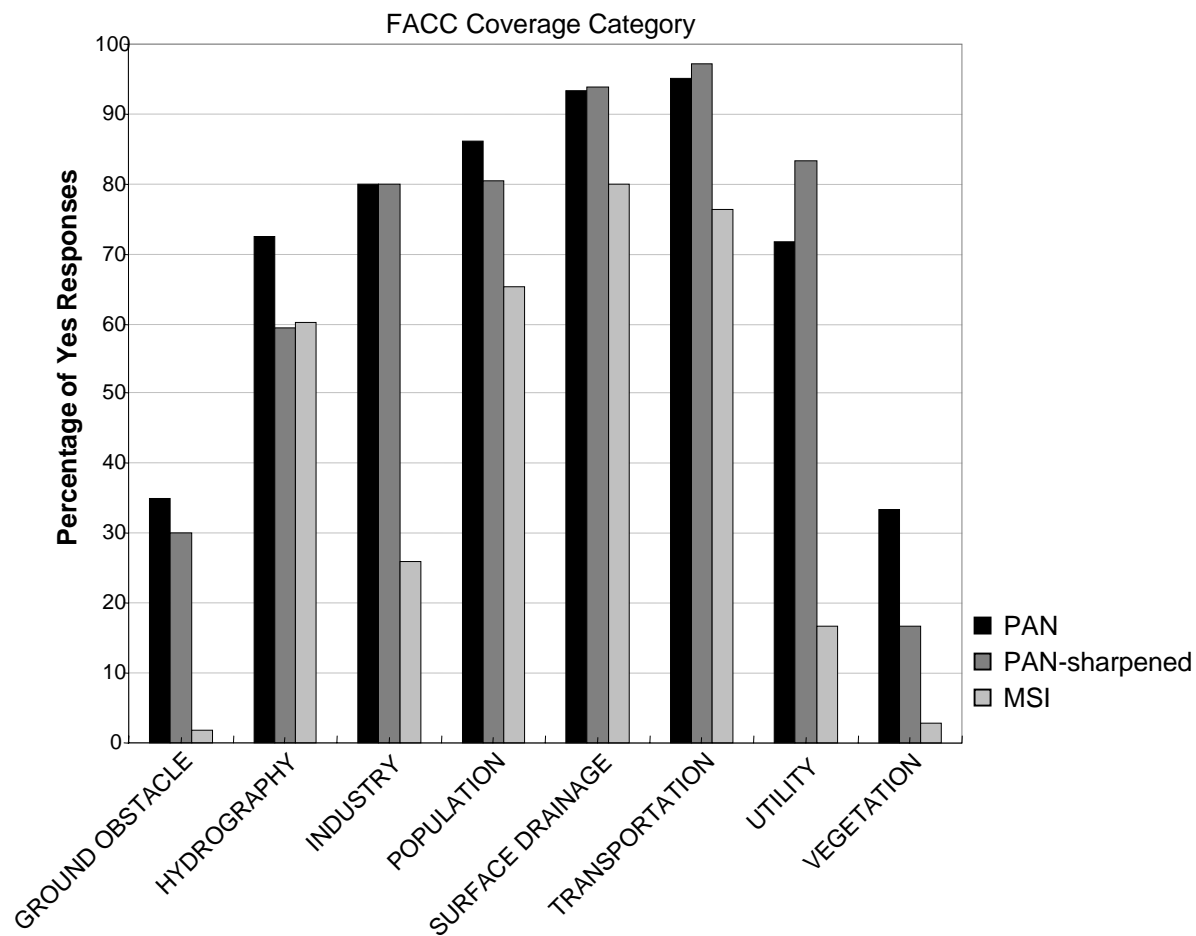

FACC Coverage Category

Positive Attribute Responses

- Yes/No questions were not represented in all coverage categories and varied in number between image types
  - No identification or mensuration questions asked in the Physiography category
  - Fewer questions asked for Pan-sharpened images (only one question asked in the Vegetation category)
- In almost all cases, Pan and Pan-sharpened image types received higher positive responses than MSI image types
  - The largest differences between Pan/Pan-sharpened and MSI were in the Ground Obstacle, Industry, and Utility categories
  - The lowest positive responses for all image types were in the Ground Obstacle and Vegetation categories
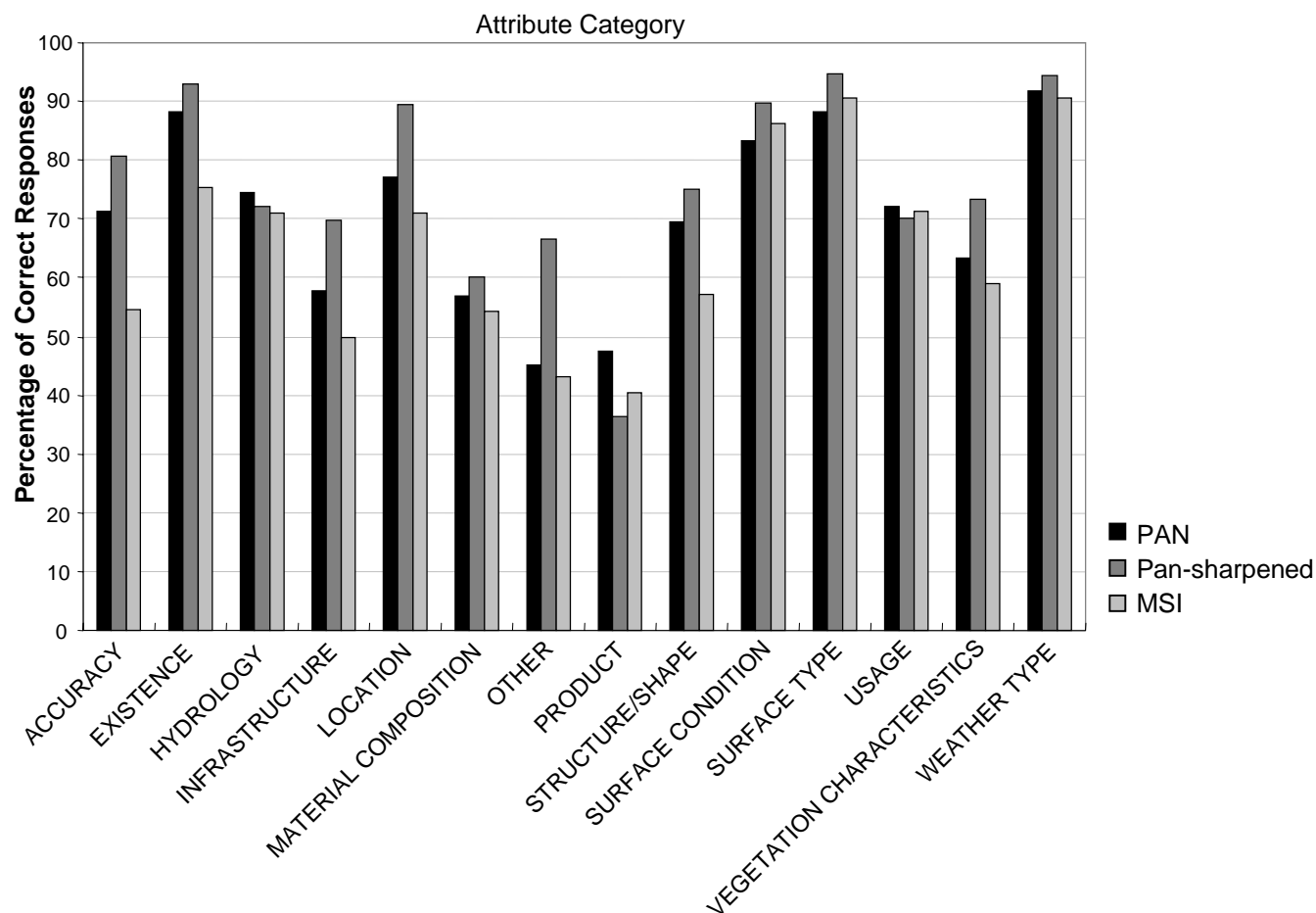
Correct Attribute Responses

Correct Attribute Responses

- In most cases, Pan-sharpened image types received higher percentages of correct responses but tracked closely with Pan image types
  - Exception being the Product category where Pan-sharpened received a slightly lower rating
  - Twelve of the fourteen categories in these image types had a correct response of 50% or higher
  - Eight categories had a correct response rate of 70% or higher
  - Four categories had a correct response rate of 80% or higher
- The correct response rate for MSI type was near Pan/Pan-sharpened in seven to eight categories
  - Seven Categories in MSI had a correct response of 70% or higher
  - Three categories had a correct response rate of 80% or higher

Conclusion

- This evaluation indicates that GAs/Cartographers use spectral content to a lesser degree than spatial content
  - Confidence ratings only modestly higher for Pan-sharpened imagery, lower for MSI
  - Attribution percentages generally lower for spectral imagery
  - MSI and Pan-sharpened MSI did out perform Pan in a few transportation-related attribute categories
- This is generally due to low analyst experience with MSI and spectral tasking
- With high overall extraction ratings, QuickBird Pan and Pan-sharpened imagery meets most requirements of GAs/Cartographers in extracting features to build NIMA map products

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